

PATENT SPECIFICATION

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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Multi-dose Needle-less Hypodermic Jet Injection Device

I, AARON ISMACH, of 3025 West 32nd Street, Brooklyn 24, New York, United States of America, a citizen of the United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 The present invention relates to medical inoculant injection instruments and more particularly to high speed multi-dose hypodermic jet injection instruments.

The present invention provides a novel combination of means for effecting a sterile inoculation of vaccine or other medicament by providing a fine jet of inoculating fluid which is impelled at high speed and with great pressure through the skin of the subject to whom the inoculant is administered.

20 The invention makes possible the delivery of an exactly metered dose of a desired vaccine beneath the skin of a patient without the use of a needle and in a relatively painless manner without breaking the surface of the skin.

The present invention provides improvements over known instruments for effecting inoculation by means of a thin high pressure stream or jet of vaccinating fluid, whereby multiple doses of vaccine may be given to a number of patients without the need for re-loading the injection instrument with a new reservoir of vaccine before each shot is administered. The present invention is particularly novel and useful in providing a jet injection instrument capable of administering inoculation shots to a very large number of patients within a very small interval of time, without any necessity for sterilization of the instrument between shots, without risk of injury or cross-infection to the patient, and with great accuracy in metering the required dosage of inoculating fluid. In practice, a

rate of inoculation of as high as 4,000 patients per hour has been achieved when administering 1/2 cc doses of vaccine.

It is an object of the instant invention to provide a jet hypodermic injection device by which inoculations can be given to more patients in a shorter time, with much greater safety and much more economically than was formerly possible either with the conventional hypodermic needles and syringes or with other types of hypodermic injection devices.

Further objects of the invention are to provide a hypodermic jet injection device which possesses a high inoculation rate, thus permitting the vaccine being administered to be changed from one type to another very easily, rapidly, and under sterile conditions. Prescribed dosages of vaccine may be administered very rapidly and accurately.

Another object of the present invention is to provide a hypodermic jet injection gun which is well balanced with a centrally disposed load, which can be operated and comfortably held by the operator in one hand, leaving the operator's other hand free to swab or grasp the patient, which is relatively noiseless and free from recoil, and which lends itself to long periods of fatigue-free operation. The latter characteristic of this invention is extremely important when inoculations are being administered by a high speed jet injection, since if the gun is permitted to slip on the arm of a patient when it is fired, a nasty cut may result.

Another object of the present invention is to provide a hypodermic jet injection device which can be quickly and easily disassembled, which can be easily and efficiently sterilized by autoclaving or other means, and which can be easily serviced by using conventional hand tools without the need for specially adapted tools or devices.

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Another object of the present invention is to provide a hydraulic jet injection gun so constructed that a failure in any one portion of the gun will be isolated to that portion and so constructed that there is a path to the exterior of the gun near each seal in the mechanism. The latter feature insures that if any one of the seals should fail, fluid (either inoculating fluid or hydraulic fluid) will appear at the surface of the gun adjacent to the seal and enable the operator to immediately discern which of the several seals has failed or is leaking.

Another object of the present invention is to provide a hypodermic jet injection device which is ideal for use in isolated areas where it is difficult to obtain spare or replacement parts, since the device uses standard components, and is relatively trouble-free, and is easy to keep in operating condition.

With the device of the present invention only the inoculating fluid goes below the skin level of the patient, and it is relatively easy to insure sterile operating conditions; whereas with conventional hypodermic injection devices part of the device itself penetrates beneath the skin and necessitates the most stringent requirements for sterility.

The present invention provides a hypodermic jet injection device, which requires no sterilization either between shots or even when the type of vaccine is changed, which delivers accurately measured doses of vaccine once it is pre-set, which is not dependent upon the operator to control the accuracy of each dose administered as conventional hypodermic devices are, and which creates no danger of cross-infection, since nothing but the inoculating fluid itself penetrates beneath the skin of the patient. The latter characteristic is especially helpful in preventing the spread of infections hepatitis, and the danger of spreading hepatitis infection is an outstanding disadvantage of the older method of administering inoculations by the use of syringes and hypodermic needles. It is possible for a patient to be a carrier of hepatitis and capable of seriously infecting another patient with the disease, although the carrier himself may show none of the symptoms associated with hepatitis. One of the outstanding benefits conferred by the invention in helping to prevent hepatitis or other cross-infection, is that if operation of the jet injection device is commenced with the device in a sterile condition, the gun will remain in its own sterility.

It is another object of the present invention to provide a hypodermic jet injection gun comprising two separate but interrelated pump mechanisms: a vaccine pump and a hydraulic pump. Both pumps are self-priming and exceptionally smooth working

in operation.

It is a further object of the present invention to provide a hypodermic jet injection gun which is of an inestimable value for use under emergency or epidemic conditions when it is essential that a great many shots be administered in the shortest possible time with a maximum amount of safety. The efficiency of design and simplicity of operation of the invention obviate the need for a skilful operator. Almost any intelligent person can satisfactorily operate the gun after a rudimentary amount of training.

Unlike most earlier hypodermic jet injection guns, the present invention is free from danger of sucking fluid back from a patient either during or after the firing cycle is completed so that the danger of cross-infection is almost completely avoided; this is obviously an important advantage at all times, but is particularly apparent when the gun is used under emergency conditions. The characteristic of the gun which permits it to be pre-set to deliver this same dose each time it is fired is of great value when the gun is used under any circumstances, but is particularly important when the gun is to be used under emergency, disaster or epidemic conditions by a relatively untrained operator.

Broadly described, the present invention comprises a hypodermic jet injection device including vaccine pump means capable of metering an exact amount of inoculating fluid into a vaccine pump chamber, outlet valve means providing a small outlet orifice for vaccine from the vaccine pump means, a piston forming part of the vaccine pump means, combined hydraulic pump and spring means for driving the vaccine pump piston very rapidly but smoothly into the vaccine pump chamber to expel a metered amount of vaccine through the outlet valve orifice in a thin stream at very high pressure and valve means for storing and selectively releasing the force of the hydraulic pump and spring means to drive the vaccine pump piston.

The invention may further comprise those features hereinafter described and as illustrated in the accompanying drawings in which:—

Fig. 1 is a central vertical section of the device;

Fig. 2 is a fragmentary enlarged section of the nozzle portion of Fig. 1;

Fig. 3 is a fragmentary enlarged section of the actuating valves and hydraulic piston portions of the device;

Fig. 4 is a section on the line 4-4 of Fig. 1;

Fig. 5 is a cross-section of the vaccine extracting tube;

Fig. 6 is a side elevation of the device in use and showing the sight port;

Fig. 7 is a plan section taken on the line 7-7 of Fig. 6;

Fig. 8 is a fragmentary section of the vaccine discharge portion of Fig. 1, showing the device cocked and ready to eject vaccine.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory, but are not only restrictive of the invention.

In accordance with the invention, a hypodermic jet injection device is provided having means to meter a prescribed dose of vaccine, means to accumulate and apply force to eject vaccine under pressure, and means to control the accumulation and release of the force. In the present preferred embodiment the means to meter the dose of vaccine comprises a vaccine pump having an intake valve and an outlet valve, the means to accumulate and apply force comprises a hydraulic cylinder and spring, and the means to control the accumulation and release of force comprises a series of hydraulic valves.

Reference will now be made in detail to the present preferred embodiment of the invention, an example of which is illustrated in the accompanying drawings, and in which the means for accumulating and applying force and pressure on the metered amount of vaccine comprises (Fig. 1) a hydraulic chamber 10, a hydraulic piston 12, a spring chamber 14, a compression spring 16, and spring guide 18. The device includes a main body 19 which in turn comprises a barrel 20 and grip 21 and the hydraulic chamber 10 and the spring chamber 14 are formed in the barrel 20. The spring chamber 14 of the barrel 20 is closed with a square cap 22 to which a dosage adjusting screw 24 is threadedly engaged. At its interior end the dosage adjusting screw 24 is provided with a thrust ball bearing 26 which bears against one end of the spring 16. The dosage adjusting screw 24 has an adjusting knob 28 secured to its exterior end to permit hand operation of the screw. At one end the spring 16 bears against the thrust ball bearing 26 and at the other end bears against the hydraulic piston 12 so that the spring may be adjustably compressed between these two bearing surfaces (thrust bearing 26 and hydraulic piston 12) by turning the dosage adjusting screw 24.

As embodied, the hydraulic piston 12 includes a plunger 30 which reciprocates in a cylinder 31 formed in the forward end of the barrel 20. Also as embodied, the means to meter vaccine comprises a vaccine pump cylinder 33 formed by a barrel extension 32 which is attached to the barrel 20 by a threaded barrel extension cap 34. The barrel extension 32 and the associated parts may be readily detached for sterilization. A vaccine pump piston 36 is secured to the hydraulic piston plunger 30 at the forward end of the plunger and the vaccine piston 36

reciprocates in the vaccine pump cylinder 33 responsive to movement of the hydraulic piston 12. Included in the vaccine pump piston 36 is a sealing ring groove 38 in which appropriate sealing rings may be mounted to seal the forward portion, or vaccine chamber 39, of the vaccine pump cylinder 33 from the rear of the cylinder.

The forward portion of the barrel extension 32 is adapted to receive a closure member 40, and the closure member 40 is held firmly in place at the end of the barrel extension 32 by a nozzle cap 42 which is threadedly engaged to the exterior of the barrel extension 32. The closure member 40 is provided with a ball check outlet valve 44 and carries appropriate sealing rings. At its forward extremity the nozzle cap 42 carries a sapphire orifice insert 46 which is bored to a very close tolerance and which determines the diameter of the jet stream of inoculating fluid.

A vaccine inlet valve 48 having a tapered inlet nose, is carried by a member 50 which is secured to the top of the barrel extension 32, and a vaccine inlet tube 52 leads from the vaccine inlet valve 48 to the vaccine chamber 39 in the barrel extension 32. A vaccine extracting tube 54 is wedged on the tapered inlet nose of the vaccine inlet valve 48 and secured thereto by conventional means. The tube 54 includes a right angle bend so that its rear portion extends in a vertical direction when the device or gun is in an upright position with the common axis of pistons 12 and 36 disposed horizontally.

Within the vertical portion of the vaccine extracting tube 54 is an air vent tube 55 of smaller diameter but substantially concentric with the removable tube 54. The tube 55 extends beyond tube 54 and is cut away at an angle to provide means for piercing the stopper of vaccine bottle 58. The outer tube 54 includes a longitudinal port 56 through which vaccine is withdrawn from a conventional vaccine bottle 58 and into the tube 54.

The air vent tube 55 diverges from the right angle bend in tube 54 and is connected to an air filter 60 which in use would be filled with sterile cotton to trap any impurities which might otherwise be drawn into the vaccine bottle 58 along with outside air as vaccine is withdrawn from the bottle.

A clip 62 (Figs. 4 and 7) is secured to the barrel 20. On top and centrally disposed on the clip 62 is a U-shaped tube support 64 which is welded or otherwise secured to the clip 62. The vaccine extracting tube 54 is held by the U-shaped tube support 64 and the support 64 is provided with two small stops 66 which come to rest against the upright portion of the tube 54 and determine the position of the clip 62 on the barrel of

the gun stock 20. The U-shaped tube support 64 also acts as a positive stop for the vaccine bottle 58 when the bottle is pushed onto the upright portion of the tube 54 to provide the vaccine supply for operation of the gun.

The U-shaped tube support 64 secures the vaccine extracting tube 54 against longitudinal movement and a spring loaded retractable lock 68 secures the tube 54 against movement away from the stock 20. The lock 68 and the tube support 64 thus cooperate to hold the tube 54 in a rigid, upright and easily accessible position and at the same time prevent the relatively delicate tube 54 from being easily dislodged and bent or otherwise damaged. The tube support 64 also acts as a channel to secure the air vent tube 55 against horizontal movement and the stops 66 in the support 64 help to secure the air vent tube from movement away from the stock 20. In use, the air vent tube 55 acts to admit air to the vaccine bottle 58 as vaccine is withdrawn and prevents the formation of a vacuum within the bottle.

A pair of bottle jaws 70 are secured to the clip 62, one jaw being attached to each side of the clip, and secured to each bottle jaw 70 is a bottle gripper 72. The bottle jaws and grippers are of a spring type to accommodate automatically any standard size vaccine bottle and lock it in a secure upright position over the grip or handle portion of the gun, the weight of the bottle being carried at the center of gravity of the gun and directly above the hand of the operator. This characteristic tends to preserve dynamic balance and reduce operator fatigue.

As embodied, the means to control the accumulation and release of force comprises the cocking mechanism, the firing mechanism, and the conduits and valves which control the application of hydraulic power to the gun; these elements are contained in the grip 21 (Figs. 1 and 3). The gun is provided with a cocking trigger 74 and a firing trigger 76. The conduits and valves contained in the grip portion of the gun control the flow of hydraulic fluid depending on the condition of the valves. In Fig. 3, the valves are shown in the static condition. The lowest valve is an unloading valve 78 and is lightly spring loaded. When the gun is not being cocked hydraulic fluid from the hydraulic pump (not shown) takes the path shown in Fig. 3, since very little pressure is required to overcome the light spring resistance of the unloading valve 78.

When the cocking trigger 74 is depressed, it moves a cocking pin 80 toward the rear of the gun and closes the unloading valve 78. With the unloading valve 78 closed by the joint action of the cocking trigger and cocking pin, the hydraulic fluid overcomes the resistance of a check valve 82 and enters

the hydraulic chamber 10 where it acts on the forward face of the piston 12 and causes the piston 12 to be moved to the rear of the gun fully compressing the spring 16.

The hydraulic pump mechanism (not shown) is provided with a pressure relief valve which acts to prevent further displacement of the piston when a certain predetermined pressure is reached in the hydraulic system. In the present embodiment the hydraulic pump (not shown) is provided with a pressure actuated switch which causes an electrical counter to advance one digit just prior to the time when the pump pressure relief valve opens. The electrical counter makes a distinctly audible click at this stage of the cycle permitting the operator to know that the gun is in the fully cocked position and obviating the need for his visual observation of any other signal that the gun is cocked and ready to fire. This use of an audible signal to indicate that the gun is in a firing condition is helpful in permitting an operator to achieve a high inoculation rate.

The trigger 76 when depressed actuates a trigger pin 84 which in turn opens a spring loaded ball check valve 86 permitting rapid escape of the hydraulic fluid from the hydraulic chamber 10. The release of the hydraulic fluid from the chamber 10 permits the spring 16 acting through intermediate parts to drive the piston 36 of the vaccine pump forward into the vaccine chamber 39 with great speed and force.

The valves and conduits necessary for proper functioning of the hydraulic system are appropriately mounted in the grip portion of the gun by conventional means and with sealing rings as required and as shown in Figs. 1 and 3. The interior ends of the inlet conduit 87 and outlet conduit 89 are provided with conventional connectors for hydraulic hose (not shown).

Both sides of the forward end of the barrel 20 are provided with a sight port 88 (Figs. 4 and 6) through which the forward end of the plunger 30 may be viewed in the present embodiment. The sight port 88 is graduated from 0.1 cc to 1.0 cc in tenths of cubic centimeters.

In operation, a conventional vaccine bottle is pressed onto the combined vaccine extracting tube 54 and air vent tube 55 and firmly secured by the bottle jaws 70 and fingers 72. The U-shaped tube support 64 acts as a positive stop to insure that the needle is inserted to the correct vertical depth in the bottle.

When the operator depresses the cocking trigger 74 the cocking pin 80 closes the unloading valve 78 causing pressurized hydraulic fluid to enter the chamber 10 and push the piston 12 to the rear against the force of the spring 16. When the spring 16

is fully compressed, the pressure relief valve on the hydraulic pump (not shown) opens to prevent further flow of fluid into the chamber 10. As previously described, a pressure actuated switch causes the electrical counter means (not shown) to advance one digit with an audible click. When the operator hears the click, he knows that the gun is fully cocked and releases pressure from the cocking trigger 74. The hydraulic fluid is trapped in the chamber 10 by the ball check valve 82 and continues to hold the spring 16 in a compressed condition.

An important and distinctive feature of the instant invention is its cocking system. During each firing cycle, the unloading valve 78 remains open except when the cocking trigger 74 is depressed. The hydraulic system is thus under load only for a brief period in each cycle when the hydraulic piston 12 is displaced against the energy of the spring 16 by hydraulic fluid pressure. When the unloading valve is in its normal position, the hydraulic system is unloaded, hence the nomenclature "unloading valve." Since the hydraulic system is under load only when the gun is actually being cocked, regardless of how long the operator waits between shots, the wear and strain on the parts of the hydraulic system during each cycle are almost negligible. This important characteristic, in practice, has permitted the gun to be fired hundreds of thousands of times without the need for overhaul or maintenance.

When the piston 12 is pushed to the rear of the gun by hydraulic fluid during the cocking operation, it acts through intermediate parts to move the vaccine pump piston 36 toward the rear an equal distance. The movement of the vaccine piston 36 to the rear tends to create a vacuum within the vaccine chamber 39 and causes vaccine to be drawn into the chamber 39 in an amount pre-determined by the distance through which the vaccine piston 12 is set to move. The vaccine is withdrawn from the bottle 58 through the port 56 into and through the vaccine extracting tube 54 past the vaccine inlet valve 48 and through the vaccine inlet tube 52 into the vaccine chamber 39. The ball check valve 44 serves to prevent the entry of any air or suckback of any fluid during the loading cycle of the vaccine pump, but the spring pressure on this valve 44 is light enough to be easily overcome during the firing or ejection cycle of the vaccine pump.

Side port 56 is employed in the tube 54 to prevent rubber from the vaccine stopper from entering the needle tube when the stopper is pierced. The side port 56 also provides a change in direction in the vaccine flow path which aids in preventing foreign particles from being entrained with the

vaccine entering the pump and clogging the outlet valve 44, the inlet valve 48, or the jet nozzle orifice 46. The concentric air vent and vaccine extraction tube 54/55 yields a stronger structure than previously known and minimizes the size of the hole which must be made in the vaccine stopper thereby effecting a better seal between stopper and tube and minimizing the tearing off of particles of rubber. This characteristic is important in helping to insure trouble-free operation, since it is not uncommon for pieces of rubber stopper to be broken off when the cut away end of the tube assembly is inserted into the vaccine bottle.

With the gun cocked, when the operator depresses the trigger 76, it acts through the firing pin 84 to open the check valve 86, and the hydraulic fluid locked in the chamber 10 is given a free path through conduit 89 back to the hydraulic pump reservoir. The release of hydraulic fluid pressure from the piston 12 permits the spring 16, acting through intermediate parts, to drive the vaccine pump piston 36 forward with tremendous force and speed. The forward movement of the vaccine pump piston 36 causes the vaccine or inoculating fluid in the chamber 39 to pass through the check valve 44 and be ejected from the front of the gun through the jewelled orifice 46 in a small diameter jet.

The conduits and passageway in the gun are constructed so as to offer a sufficient resistance to provide hydraulic damping to the forward movement of the piston 12. This damping is in addition to the damping normally attained due to the resistance encountered by the vaccine as it is forced through the jet orifice. This additional damping permits the unit to be dry fired (no vaccine in the vaccine pump) with no mechanical damage occurring to any portion of the injection unit. This feature assures that there will be no break in service if the operator accidentally does not renew the vaccine supply after the vaccine bottle in use has been emptied.

The use of a jewelled orifice as the ejection port has been found particularly advantageous, since it permits the machining of the opening to very close tolerances; and since the finished jewelled tip is semi-transparent, it is very easy to determine under examination with optical instruments whether or not the completed tip provides a smooth and uniform orifice. If a metal tip were used, it would be almost impossible to test its suitability directly by optical tests. In the present preferred embodiment, the diameter of the jewelled orifice 46 which has been found to be most advantageous in achieving the results of the invention in practice is .005 inch with a tolerance of plus

.0002 inch minus zero.

A protective cap is provided to protect the jewelled tip and sterile gauze may be inserted in the cap to keep the vaccine pump section of the gun sterile during brief interruptions in use.

A sandpaper or abrasive disc 90 is provided on the flat front surface of the nozzle 42. This disc has been found of great help in practice to prevent the ejection tip of the gun from slipping or sliding on the skin surface of a patient when an ejection is being made. Without such means to prevent slippage, perspiration on the skin surface makes the gun particularly susceptible to slippage, and if the gun slips when it is being fired a severe cut can result from the knife-like action of the high pressure jet of fluid.

In the present embodiment (Fig. 2), sealing ring 92 is mounted in the closure member 40. Preferably, this is made of a synthetic plastic, such as Teflon (Registered Trade Mark), which unlike a rubber sealing ring, is not susceptible to breaking off in small particles. This assembly provides a particularly effective seal since the closure member 40 is of a floating type. This floating feature provides that if the nozzle is loosely screwed onto the barrel extension 32 by the operator, or if the plastic sealing ring flattens in use, as is normal, no loss of sealing efficiency between the jet nozzle and the pump cylinder occurs. When an injection is fired, the thrust of the vaccine propels the floating closure member forward with sufficient force to automatically maintain an excellent hydraulic seal between these members. This feature is of prime importance in insuring that all vaccine is ejected through the orifice, with proper pressure and velocity, and that none leaks past the threaded joint between nozzle and barrel extension 32 to reduce the effective dose and depth of penetration of the vaccine.

The vaccine inlet valve 48 and its supporting member 50 are mounted on the barrel extension 32 and clear of the nozzle. This arrangement keeps the shooting end of the gun clear and uncluttered so that the operator has an unobscured view of the nozzle as it is placed in contact with the skin of the patient.

The vaccine pump is self-priming, which is an advantageous feature of the invention in practice. After loading a new bottle of vaccine onto the device, the operator may purge the vaccine pump of air and place it in condition to fire an injection by merely shooting it into the air twice.

Another advantageous feature of the present embodiment is that the ball of the vaccine inlet valve 48 floats in the valve chamber and is free to rotate. On the feed

or inlet cycle of the vaccine pump, the ball permits the free flow of vaccine into the vaccine feed tube through a series of slots 53 at the rear end of the tube. When the gun is fired, however, the pressure created in the vaccine chamber 39 transmitted through the feed tube 52 forces the ball of the inlet valve 48 tightly against its seat in the valve chamber and prevents any backflow of fluid through the vaccine extracting tube 54. The seat of the valve 48 is constructed so that a substantial surface of the ball is in contact with the seat when the valve is acting as a check; this reduces wear on the ball itself to a minimum. Accordingly, the latter feature and the construction which permits the ball to rotate freely between cycles of the vaccine pump ensure a long life for the valve in spite of its small size and subjection to high pressure every time the gun is fired.

In operation, the operator controls the dosage of vaccine to be administered by turning the dosage adjusting screw 24 through the knob 28. When a larger dose is desired the adjusting screw 24 is moved towards the rear of the gun, and when a smaller dose is desired, the screw is moved toward the front of the gun. As the screw 24 is moved toward the front of the gun, it places the spring 16 under partial compression. The pressure relief valve on the hydraulic pump is set to operate when the spring 16 is fully compressed. If the dosage adjusting screw has already partially compressed the spring 16, it is obvious that the vaccine pump piston 36 will only move as far to the rear of the gun under hydraulic fluid pressure as is necessary to complete compression of the spring 16. Accordingly, the degree to which the vacuum pump piston 36 moves to the rear can be directly controlled by the dosage screw 24, and the degree to which the piston moves to the rear obviously determines the amount of vaccine drawn into the vaccine pump chamber 39 and the amount which is ejected upon firing.

In practice, the extent to which the spring 16 is finally compressed is determined by the magnitude of the hydraulic fluid pressure, which, in turn, is controlled by the pressure relief valve on the hydraulic fluid pump (not shown). Regardless of dosage to be administered, the spring 16 is compressed to the same degree each time the gun is cocked. This characteristic insures that the vaccine ejection force will always be the same at the instant the firing trigger is depressed, no matter what volume dose is being administered. Screwing in the dosage adjusting screw 24 merely pre-compresses the firing spring 16 mechanically so that the hydraulic fluid will only be required to further compress the spring a short distance

before the gun is fully cocked. If the dosage adjusting screw is turned in all the way, only a very slight further compression of the spring is possible, and in the present embodiment, the vaccine piston 36 can only move back the equivalent of 0.1 cc. of vaccine dose. Whereas, if the dosage adjusting screw is turned out all the way, the spring must be compressed through its full acting distance, by the hydraulic system, and in the present embodiment, a 1.0 cc. dose will be administered. An interior shoulder 23 of hub of the cap 22 acts as a positive stop to prevent the dosage adjusting screw 24 from being turned in too far.

Of course, the characteristic last described is an important advantage of the present embodiment, since it guarantees that regardless of the size of the dose, the injection force at the start of the firing stroke is always the same and imparts to the jet of inoculating fluid the correct speed and pressure for insuring an effective hypodermic injection.

WHAT I CLAIM IS:—

1. A hypodermic jet injection instrument having a body with a rear chamber and a forward chamber, a piston reciprocally mounted in the rear chamber, means for biasing the piston in a forward position in the rear chamber, a plunger reciprocally mounted in the forward chamber, means connecting the plunger to the piston so that the plunger moves in response to the movement of the piston, an external source of fluid under continual flow, means for directing the fluid to the rear chamber whereby the pressure on the fluid is raised sufficiently to overcome the forward bias of the piston, and means for releasing the fluid from the rear chamber.

2. The invention as defined in claim 1, in which the means for directing the fluid to the rear chamber comprises a first conduit for directing the fluid from the source to the rear chamber, and in which the means for releasing the fluid from the rear chamber comprises a second conduit for returning the fluid to the source.

3. The invention as defined in claim 2, which includes a by-pass interconnecting the first and second conduits.

4. The invention as defined in any of the foregoing claims, in which the means for directing the fluid to the rear chamber includes a check valve to prevent back-flow of fluid through said means.

5. The invention as defined in any of the foregoing claims, in which the means for releasing the fluid includes a manually operable valve to control release of the fluid.

6. The invention as defined in claim 3, which includes a normally open manually operable valve for selectively closing the

by-pass to divert the fluid to the rear chamber.

7. The invention as defined in claim 1, in which the means for directing the fluid includes a first conduit for directing the fluid from the source to the rear chamber, the means for releasing the fluid includes a second conduit for returning the fluid from the rear chamber to the source, and which also includes a by-pass interconnecting the first and second conduits, a check valve in the first conduit for preventing back-flow of fluid from the rear chamber, a normally open manually operable valve for selectively closing the by-pass to direct fluid through the first conduit into the rear chamber, and a manually operable valve for selectively releasing fluid trapped in the rear chamber through the second conduit back to the source.

8. The invention as defined in any of the foregoing claims, in which the forward chamber has an outlet orifice of a very much smaller cross-section than the cross-section of the chamber.

9. The invention as defined in any of the foregoing claims, in which the forward chamber has an outlet orifice of greatly reduced cross-section relative to the cross-section of the chamber and a sealing member between the plunger and the orifice, the sealing member being axially movable under inoculating fluid pressure exerted by the plunger to effect a fluid tight seal in the forward chamber around the orifice.

10. The invention as defined in any of the foregoing claims, including means for variably and continuously controlling the capacity of the forward chamber.

11. The invention as defined in any of the foregoing claims, which includes an inoculating fluid reservoir and a passageway leading from the reservoir into the forward chamber.

12. The invention according to claim 11, which includes valve means to prevent return of inoculating fluid from the forward chamber to the reservoir through the passageway.

13. The invention as defined in claims 11 or 12, which includes valve means to prevent admission of air through the outlet orifice while inoculating fluid is being drawn into the forward chamber from the reservoir.

14. The invention as defined in any of the foregoing claims, which includes means visible from the exterior of the body to indicate the position of the plunger in the forward chamber.

15. The invention as defined in any one of claims 8 to 19, in which the outlet orifice is formed from a jewel.

16. The invention as defined in any of the foregoing claims, in which the piston is

biased in its forward position by a spring.

17. The invention as defined in any of the foregoing claims, in which the forward chamber and the plunger are detachable
5 from the instrument for sterilization.

18. A hypodermic jet injection instrument, substantially as hereinbefore described and illustrated in the accompanying drawings.

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Chartered Patent Agents.

Reference has been directed in pursuance of Section 9 subsection (1) of the Patents Act, 1949, to patents Nos. 798,826 and 798,827.

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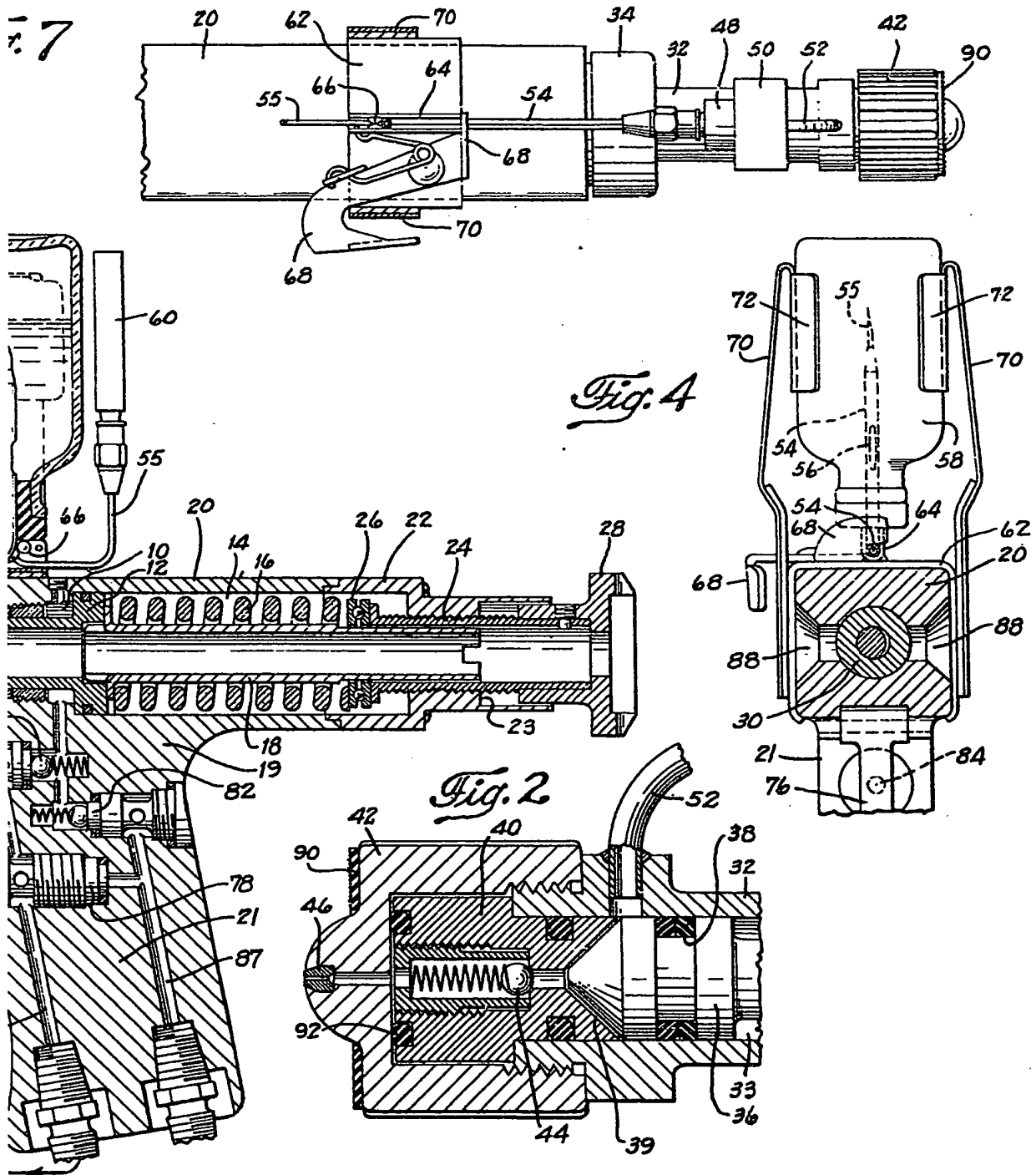


Fig. 7

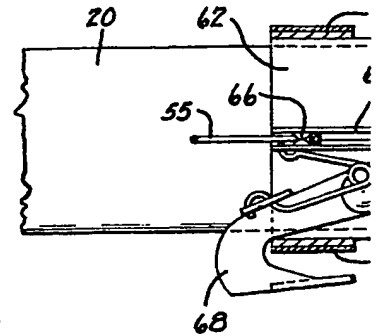
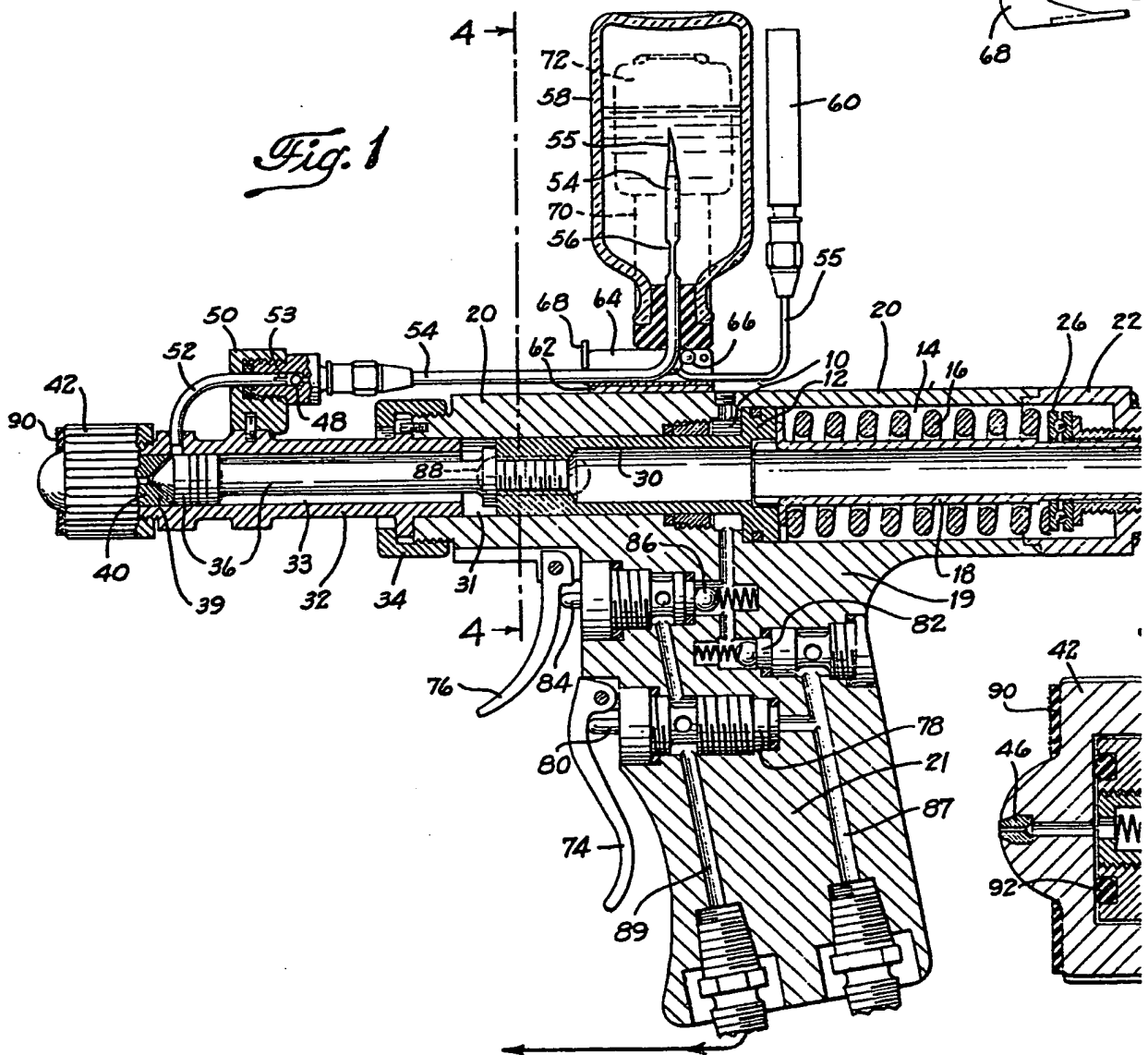


Fig. 1



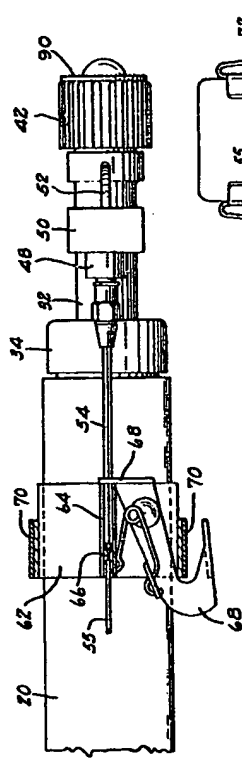


Fig. 7

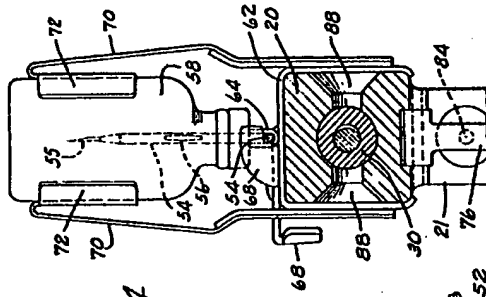


Fig. 4

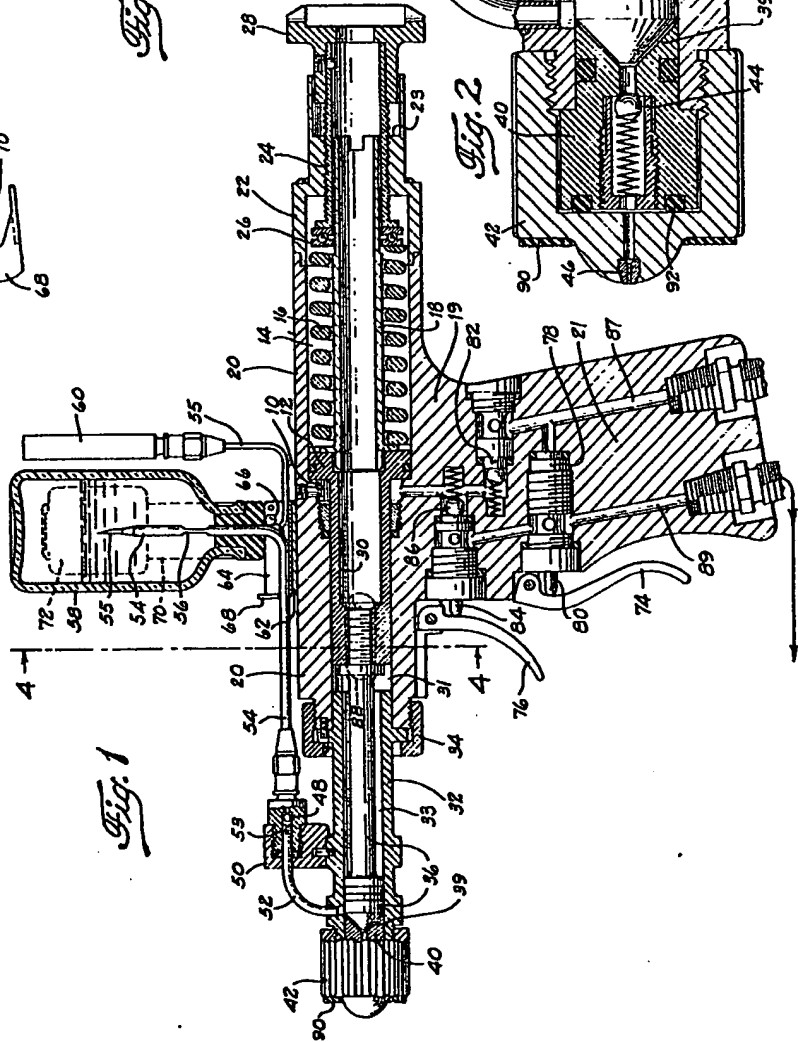


Fig. 1

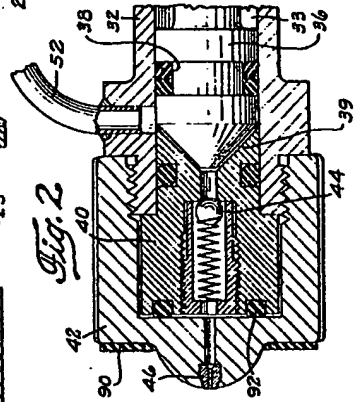
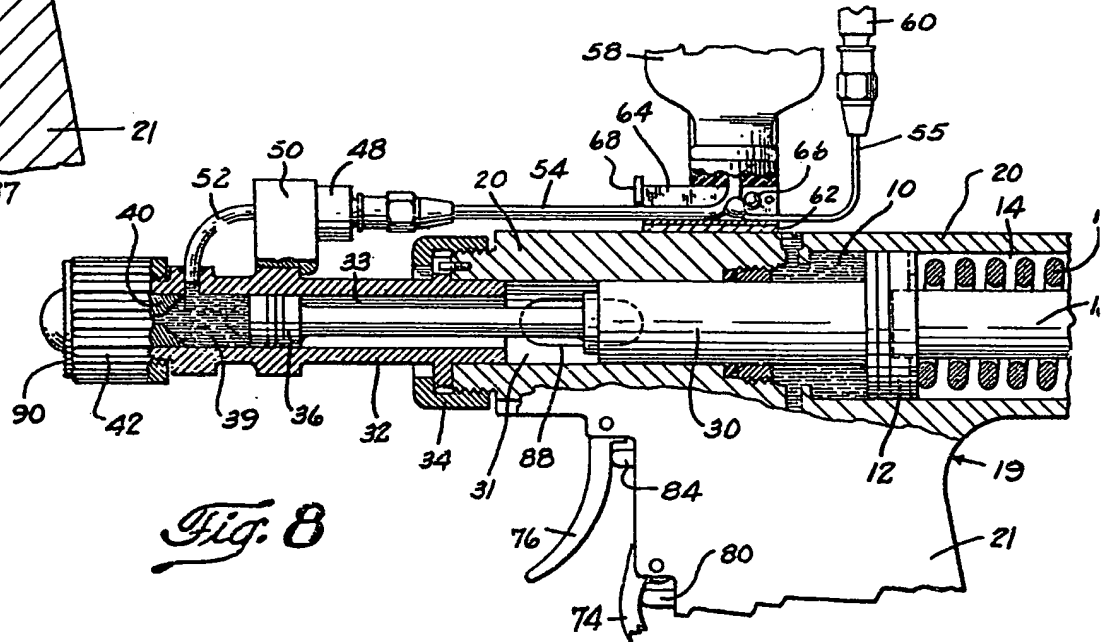
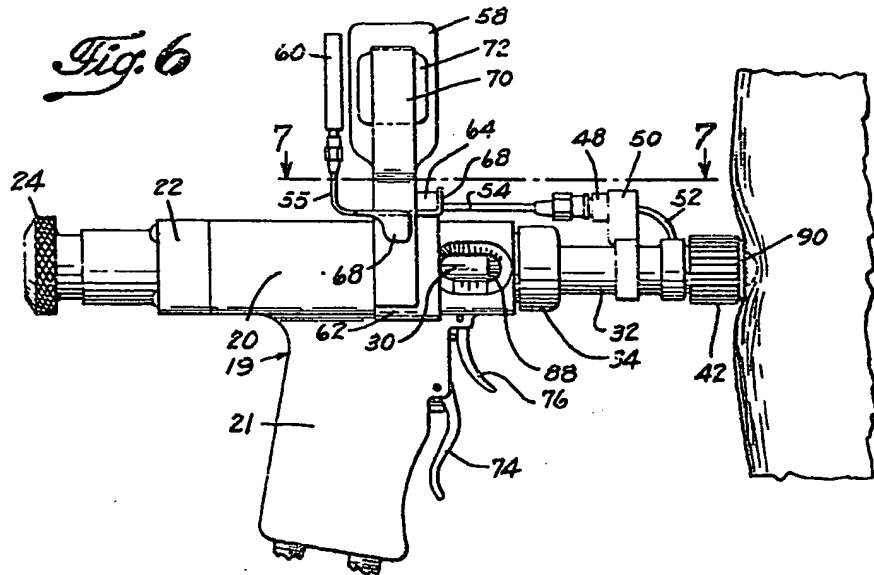
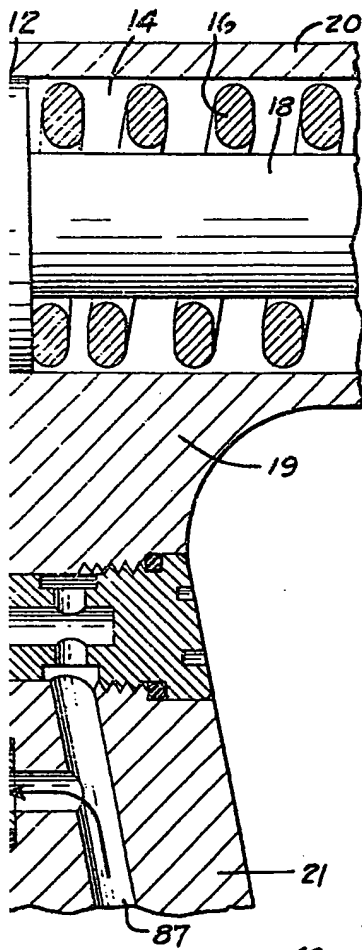
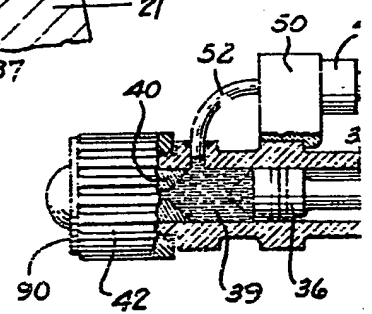
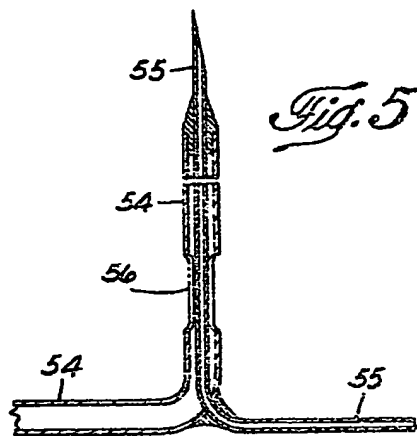
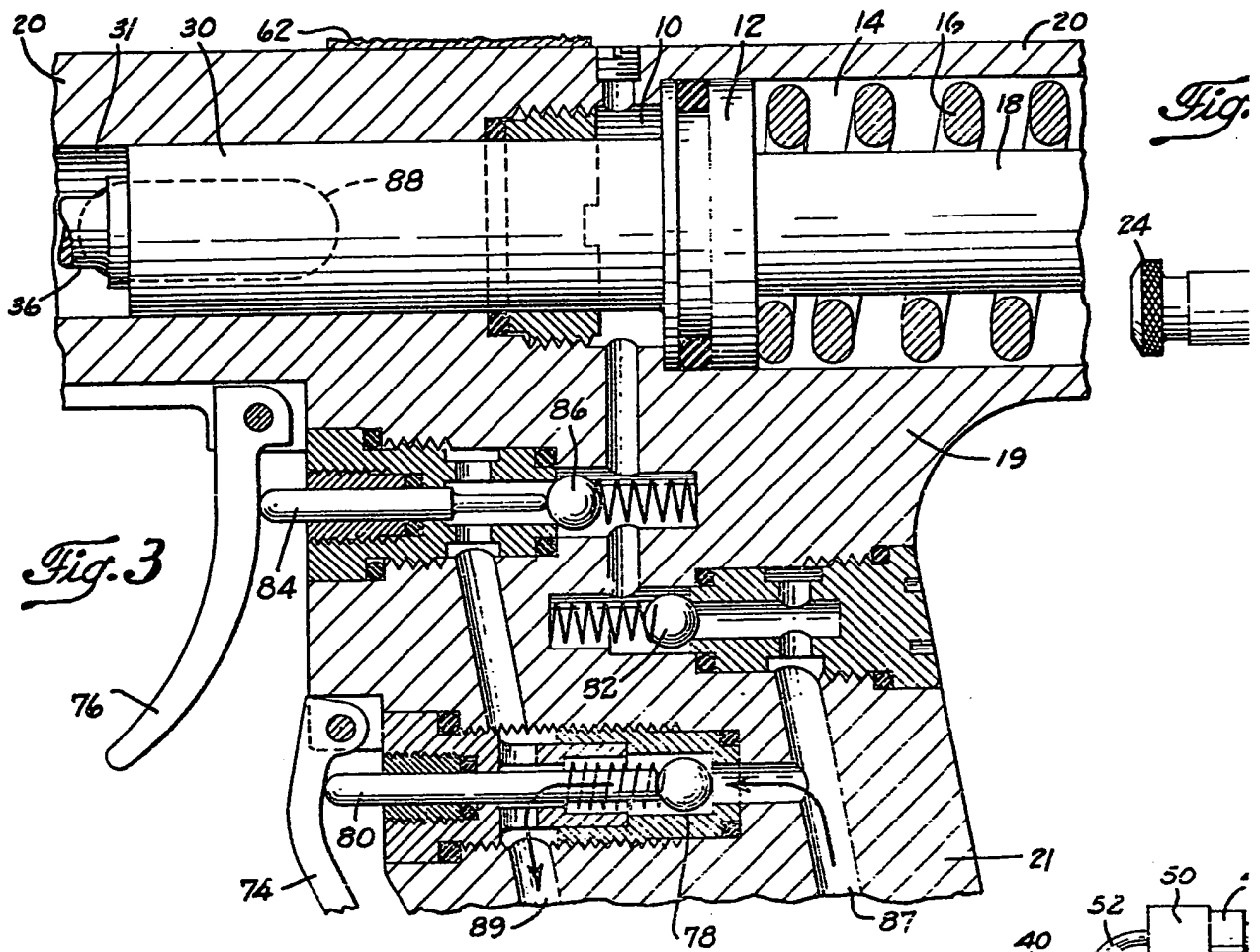
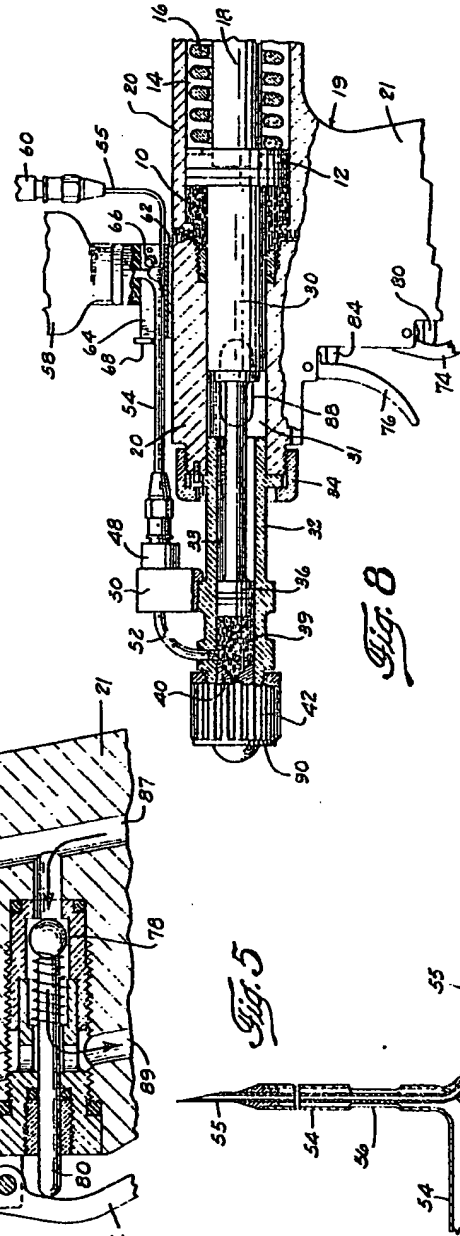
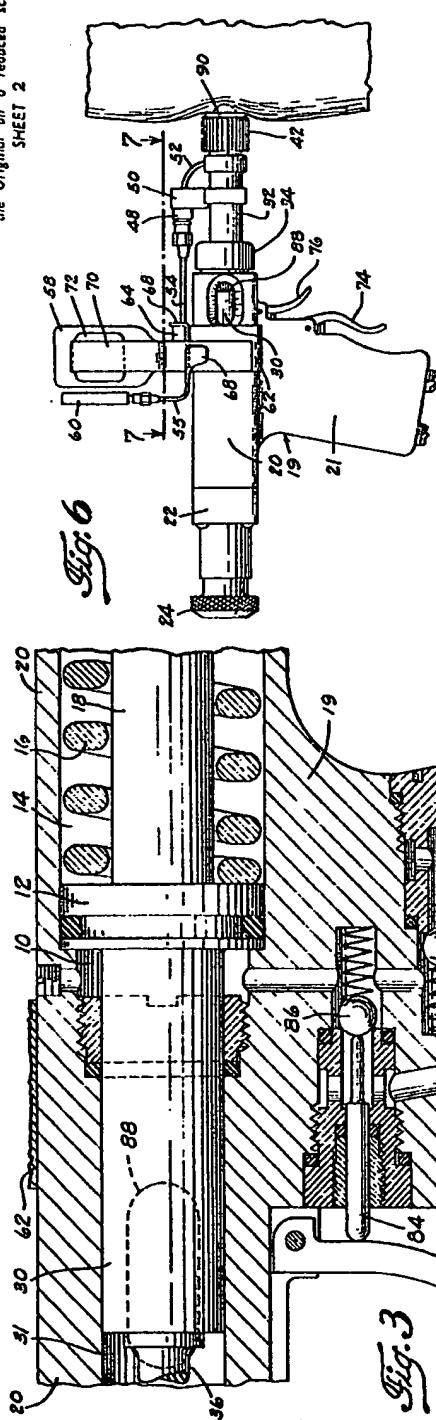


Fig. 2







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